

**Unit Specific Crew Rest Strategies: Phase I
Evaluation of the 1/212th Aviation Battalion
During Shiftwork Transitions**

By

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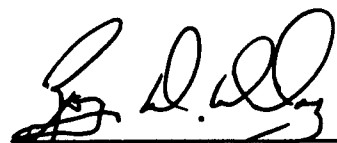
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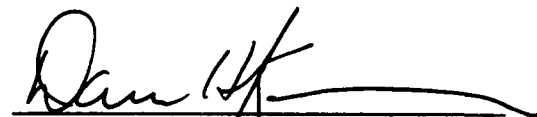
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19. (Continued) regulating the body's biological clock to prevent sleep loss during a characteristic mission. This report contains a summation of the results of a phase I evaluation of shiftwork schedules used by the 1/212th Army Aviation Training Battalion at Fort Rucker, Alabama. Shiftwork schedules used by 1/212th aviators and aircrew included shifts from daytime to early morning, to nighttime, and to afternoon duty hours. The operational objectives of the crew rest evaluation study were twofold: 1) to assess the impact on crew rest of rapid transitions from daytime to nighttime and early morning duty hours; and 2) to provide the commander of the 1/212th with recommendations that would update the unit's presently used crew rest strategy.

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Military significance

Army aviation personnel often transition through standard daytime (0700 to 1600), nighttime (2000 to 0400), and early morning (0500 to 1300) duty hours. Although reporting times may vary in response to specific mission requirements, personnel usually rotate in a backwards direction from day to early morning or from day to night and in a forward direction from early morning to day and from night to day. Mission objectives often require an initial shift from daytime to nighttime or early morning duty hours within 24 to 48 hours. Since the successful accomplishment of any mission depends on team coordination, cohesiveness, and effectiveness, the state of alertness and readiness of each member of the team are critical elements to mission success. Performance, alertness, and overall energy level can be degraded significantly during transitions from one work schedule to another, particularly when the speed of rotation is limited to 24 hours (for a review see Comperatore et al., 1993; Comperatore and Krueger, 1990; Scott and Ladou, 1990; Winget et al., 1984).

Today's Army aviation commander is deeply concerned with the implementation of crew rest strategies which are both practical and effective. Maintaining peak performance of individuals rotating from one work shift to another is of paramount concern. General guidelines often provide appropriate information, but do not provide strategies or specific schedules of crew rest tailored to the unit's specific mission demands, environmental conditions, and strength. An alternative to general recommendations and guidelines is the use of unit specific crew rest strategies. This concept involves a two-phase process. In phase I, the unit's existing response to a characteristic mission or training exercise is evaluated by determining the amount of rest obtained by a representative sample of crew members. This is accomplished by using individual activity monitors worn by unit personnel throughout the evaluation period. Data produced by activity monitors allow the construction of individual activity/rest profiles and the determination of the duration of rest periods as crew members transition from daytime to nighttime or daytime to early morning hours. Shiftwork transitions and specific circumstances resulting in significant reductions of rest time can be identified by studying individual crew activity/rest patterns, mission requirements, environmental conditions, and personnel strength assigned to the accomplishment of mission objectives (Comperatore et al., 1993).

The results of phase I evaluations provide descriptive information on daily rest periods, and on the impact of mission-driven work schedules and environmental conditions on crew rest. Phase II provides the unit with the most current information

available on physiological rhythms, sleep/wake cycles, shiftwork schedules, and methods for regulating the body's biological clock to prevent sleep loss during a characteristic mission (Comperatore, 1993). The results of the evaluation study are discussed with the unit's commander and staff members responsible for the implementation of the unit's work schedules. In coordination with the unit's command staff, the coping strategy then is developed and adapted to the specific mission demands and environmental circumstances which unit members usually experience in the field.

This report summarizes the results of a phase I evaluation of shiftwork schedules used by the 1/212th Army Aviation Training Battalion at Fort Rucker, Alabama. Shiftwork schedules used by 1/212th aviators and aircrew included shifts from daytime to early morning, to nighttime, and to afternoon duty hours. The operational objectives of the crew rest evaluation study were twofold: 1) to assess the impact of rapid transitions from daytime to nighttime and early morning duty hours on crew rest of this unit; and 2) to provide the commander with recommendations that would update the unit's existing crew rest strategy.

General approach

The evaluation protocol was designed to assess the timing and duration of rest that aviators obtained during rapid transitions from daytime to nighttime or early morning duty hours. This assessment required the study of activity/rest rhythms during consecutive days of work involving shiftwork transitions. Daily activity/rest data were obtained from wrist activity monitors worn by aviators 24 hours a day throughout a period of 14 consecutive days. The following dependent variables were assessed throughout the training period: (1) daily bedtimes; (2) daily rise times; and (3) duration and timing of daily bedrest.

Methods

Participants

A total of 24 (23 male, 1 female) Army aviators participated in the study. Data presented here are from the 17 participants who complied with the guidelines for the use of activity monitors, thus providing complete activity/rest data sets. Participation was voluntary and withdrawal from the study was allowed at any time without penalty. Each subject was informed of the project's objectives and of the procedures to be implemented throughout the study. Details of the objectives, procedures, and methods of this study were presented in written form.

Apparatus

Wrist activity monitor (WAM)

The WAM is a water-resistant metal box, approximately 66 mm x 43 mm x 15 mm, containing a piezoelectric motion sensor, an 8-bit microprocessor powered by a lithium battery, 32 kb of nonvolatile RAM, and a real-time clock. It was worn on the nondominant arm. WAMs were set up to detect accelerations exceeding 0.1 g and were used in the threshold crossing mode. In this mode, single counts were registered for each signal that crossed through a predetermined voltage baseline reference. Each crossing indicated a movement count, thus yielding frequency of body movements per minute or activity level per minute. Normal movement of an awake individual was empirically observed to consistently result in an average of at least 50 counts per 30 minutes, or greater than approximately 2 counts/minute over a 30-minute period.

Procedure

Participants were asked to carry out their activities without attempting to change their normal and customary approach to shiftwork changes.

Schedule evaluation strategy

The operational objectives of this study were to describe the work-rest schedule experienced by aviators during the transition from diurnal to nocturnal or early morning duty hours. These objectives required the daily documentation of bedtimes, rise times, and total bedrest duration. WAM activity data were analyzed by plotting activity counts per minute over time for each day of participation. The examination of activity plots allowed the determination of the above variables as follows:

Bedtimes

Clock times associated with the beginning of a time period exceeding 2 consecutive hours of less than 50 activity counts per 30 minutes were designated as bedtimes. Although zero threshold movement frequency is desirable for the determination of sleep related immobility, minor body movements can be detected as low level counts. The criterion of less than 50 activity counts per 30 minutes allows for normal body movements that occur during sleep without erroneously assuming wakefulness time.

Rise times

Clock times associated with the beginning of a time period exceeding 2 consecutive hours of 50 activity counts per 30 minutes and followed by persistently high activity levels were scored as periods of continuous wakefulness. The clock time associated with the beginning of the period of continuous wakefulness was designated as rise time.

Sleep and wakeup times recorded from personal log entries were used instead of bedtimes and rise times in cases of WAM malfunction. This procedure was necessary in only two cases and for no more than 2 days.

Total daily bedrest duration

Daily bedrest duration was determined by continuously recording average activity counts below 50 per 30 minutes between bedtimes and rise times. Periods of wakefulness during bedrest were indicated by momentary increments in activity counts above 50 which did not persist for more than 2 consecutive 30-minute periods.

Participants were expected to use individual strategies to cope with the rapid transition from daytime to nighttime and early morning duty hours. Social and family situations were expected to influence bedtimes, rise times, and total bedrest duration. These variables were not experimentally controlled.

Data analysis

For the purpose of analysis, aviators were grouped into one of five categories, as follows:

1) Early morning transition group (EM). Aviators transitioning from a daytime reporting time (0700-1000 hours) to early morning reporting times (0500-0700).

2) Afternoon transition group (AFT). Aviators transitioning from daytime (0700-1000) to afternoon reporting times (1200-1700).

3) Nighttime transition group (NIT). Aviators transitioning from daytime (0700-1000) to nighttime (1900-2400) reporting times.

4) Daytime group (DAY). Aviators on permanent daytime reporting times.

5) Nighttime group (N). Aviators on permanent nighttime reporting times.

For all groups, bedtimes, rise times, and total bedrest duration were recorded over 14 consecutive days. The number of days in each work schedule (e.g., day vs early morning) varied among individuals. Consequently, averages are presented for individuals as well as for groups. Group data are presented only in cases when total group membership is five or more.

Results

Activity/rest patterns

Aviators transitioning from daytime to early morning shift

Seven aviators worked schedules which required frequent shifts from daytime (0070-0800) to early morning (0500-0700) reporting times. Activity/rest patterns revealed a consistent advance of bedtime and rise times during the early morning shift. Bedrest duration was usually shortened during the transition days and extended after the return to daytime duty hours (see Figures 1 through 7). The delay in bedtimes indicates a lack of stability and the potential occurrence of sleep loss due to the relative stability of rise times (see Figure 5, days 8-11).

Five of the seven participants exhibited steady state entrainment during early morning work schedules. In these cases, the transition to earlier bedtimes occurred without severe disruptions in the stability and predictability of daily bedtimes. The stability of both bedtimes and rise times is illustrated in Figure 2 (days 7-11 and 14-18), Figure 3 (days 7-11), Figure 4 (days 7-8, 10-11, and 14), Figure 6 (days 14-18), and Figure 7 (days 1-4, 6-8, 10-11, and 13-14).

This was not the case for two subjects who exhibited daily advances or delays in bedtimes and rise times during the transition to early morning and sometimes during daytime duty hours. In these two cases, the drifts in bedtime resulted in a delay of steady state entrainment to the early morning schedules, thus promoting sleep loss during shiftwork transitions. Figure 1 illustrates a case in which bedtimes were unstable during the first transition to the EM workschedule (days 5-8). Stability, thus steady state, finally was achieved on days 9-10 and was maintained on days 13-17 (see Figure 1).

A second case of lack of rhythm stability is illustrated in Figure 5, days 8-11 and 15-17. In this particular case, work schedules included nighttime, early morning, and daytime duty hours. The abrupt changes from day to night, to early morning, to night, to early morning, and finally to daytime duty hours

resulted in a lack of rhythm stability throughout the study period (see Figure 5). Notice that bedtimes drifted continuously to a delayed position, except when the shiftwork change occurred from nighttime to early morning work schedules (Figure 5, days 7-8 and 14-15).

The lack of rhythm stability and the consistent reduction in bedrest duration during transitions to early morning work schedules depict shiftwork maladaptation for the early morning group.

Bedtimes and rise times

During daytime duty hours, the 7 aviators in group EM retired at an average clock time of 2320 (SD = 59.9 minutes; Range: 2209 to 0044) and rose at an average clock time of 0728 (SD = 44.6 minutes; Range: 0625 to 0831). After transitions to early morning duty hours, aviators retired earlier at an average clock time of 2159 (SD = 51.2 minutes; Range: 2051 to 2305) and woke up earlier at an average clock time of 0416 (SD = 29.6 minutes; Range: 0322 to 0450). Table 1 presents average bedtimes and rise times for each subject, and the overall averages for the group.

Average bedrest duration

In general, transitions to early morning duty hours resulted in loss of total bedrest duration (see Table 2, bedrest duration). Average bedrest decreased from 8.04 hours (SD = 0.80 hours; Range: 6.98 hours to 9.78 hours) during daytime duty hours to 6.25 hours (SD = 0.50 hours; Range: 5.43 hours to 7.03 hours) during early morning duty hours. All 7 aviators in the EM group showed reductions in bedrest duration during transitions to early morning reporting times.

Aviators transitioning from daytime to nighttime shift

Four subjects worked schedules that required transitions from daytime (0600-0800 hours) to nighttime (1800-2100) reporting times. Examination of activity/rest patterns revealed appropriate delay patterns of bedtimes and rise times after transitions to nighttime duty hours, resulting in the preservation of daily bedrest duration. This adaptive response is illustrated in Figure 5 (days 2-7, and day 14), Figure 10 (days 3-4 and day 9), and Figure 11 (days 4-8 and day 12). Bedrest duration was not reduced for participants number 8, 10, and 11 (Figures 8, 10, and 11). Participant number 9 exhibited a consistent pattern of bedrest reduction after nighttime duty hours (see Figure 9). In this particular case, bedtimes ranged

from 0100 to 0800 and rise times from 0650 to 1450. This variability in the timing of sleep characterizes shiftwork maladaptation.

Bedtimes and rise times

During daytime duty hours aviators retired at an average clock time of 2421 (SD = 89.3 minutes; Range: 2222 to 0150), and rose at an average clock time of 0759 (SD = 55.2 minutes; Range: 0637 to 0832). After transitions to nighttime duty hours, aviators retired later at an average bedtime of 0212 (SD = 41.3 minutes; Range: 0132 to 0305) and rose later at an average clock time of 0917 (SD = 23.6 minutes; Range: 0857 to 0947; see Table 3).

Average bedrest duration

In general, aviators' nighttime duty hours did not result in a consistent loss of total bedrest duration (see Table 4, bedrest duration). Average bedrest changed from an average 8.05 hours (SD = 0.92 hours; Range: 6.72 to 8.83 hours) during daytime duty hours to an average of 7.2 hours (SD = 0.69 hours; Range: 6.25 to 7.88 hours) during nighttime duty hours.

Aviators transitioning from daytime to afternoon shift

Three subjects transitioned from daytime duty hours to afternoon reporting times. This work schedule involved evening/nighttime flying. Examination of activity rest patterns revealed consistent bedtimes, rise times, and the preservation of daily total bedrest duration throughout the entire activity record (see Figures 12, 13, and 14). Tables 5 and 6 present each subject's average bedtimes, rise times, and bedrest duration.

Bedtimes and rise times

During daytime duty hours, aviators in group AFT retired at an average clock time of 2246 (SD = 89.4 minutes; Range: 2104 to 2353) and rose at an average clock time of 0620 (SD = 68.1 minutes; Range: 0522 to 0735). After transitions to afternoon reporting times, aviators retired at an average clock time of 2349 (SD = 75.8 minutes; Range: 2222 to 0042) and rose at an average clock time of 0923 (SD = 29.7 minutes; Range: 0857 to 0955). (See Table 5, average bed and rise times.)

Average bedrest duration

All three subjects exhibited a consistent pattern of delayed bedtimes and rise times after transitioning to afternoon reporting times. The effect of afternoon shift on rise times can be observed by comparing day and afternoon rise times in aviators' activity/rest profiles (Figures 12-14). In general, transition to nighttime duty hours resulted in a consistent increase of daily bedrest duration. Average bedrest changed from an average of 7.50 hours (SD = 1.15; Range: 6.17 to 8.17 hours) during daytime duty hours to an average of 9.23 hours (SD = 1.29; Range: 8.15 to 10.65 hours) during afternoon duty hours. (See Table 6.)

Aviators on permanent work schedules

Three subjects worked permanent work schedules, two on daytime and one on nighttime duty hours. All three subjects exhibited consistent bedtimes, rise times, and bedrest durations. Subjects in the daytime schedule rested an average of 7.74 hours per day, retired between 2219 to 2352, and rose between 0524 and 0652 (Tables 7 and 8 and Figures 15-16). The only subject working consecutive nighttime duty hours rested an average of 8.43 hours, retired at 0229, and rose at 1055 (Figure 17 and Tables 9 and 10).

Conclusions

Rotations from daytime to early morning and daytime to afternoon work schedules resulted in opposite effects on bedrest duration. Early morning work schedules invariably required an advance in bedtime and rise times. Aviators successfully retired and awoke earlier after rotating to early morning work schedules (see Table 1); however, the duration of daily rest was consistently reduced for all subjects (see Table 2). Lack of preservation of bedrest duration after transitions to early morning shift indicates that consistently advancing bedtimes and rise times is not sufficient to fully adapt the sleep/wake cycle to the new work schedule. This observation is in agreement with studies on the effects of backward shift work rotation (daytime to early morning) on sleep duration (Monk and Folkard, 1992a). Forward rotations (day to afternoon; afternoon to night) usually result in preservation of the sleep period. Backward rotations are more difficult for human physiology and require several days of adaptation time (Monk and Folkard, 1992b).

In contrast, when aviators rotated from daytime to afternoon work schedules, daily bedrest duration was not only preserved, but increased (see Figures 12-14). In this particular case, the preservation of bedrest duration is associated closely with

the consistent delay in bedtimes and rise times (see Table 5), and the direction of the rotation (forward).

A third group of subjects, rotating into nighttime duty hours, also experienced a forward rotation. In most cases, aviators delayed bedtimes and rise times, and preserved daily bedrest duration throughout the evaluation period (See Figures 8-11). This observation is in agreement with a recent phase I evaluation in which aviators implemented a crew rest strategy requiring consistent delays of sleep onset during frequent shifts to nighttime duty hours (Comperatore et al., 1993).

Specific recommendations to the 1/212th Aviation Battalion

1. Bright light exposure

Since the early morning group experienced a consistent loss of sleep, it can be assumed that individuals did not physiologically adapt to the new work schedule. One way of facilitating adaptation to an advance of wake up time is to expose the individual to bright artificial light (above 2,000 lux) upon awakening. Bright light exposure has been shown to decrease fatigue and increase alertness in several experiments involving shiftwork rotations and sleep loss (Czeisler et al., 1990). In addition, changing the timing of bright light exposure has been shown to reset the timing of the sleep/wake cycle (Czeisler et al., 1986). Thus, the onset of the sleep period can be advanced or delayed with planned bright light exposure (Czeisler, Moore-Ede, and Coleman, 1982).

During early morning rotations, subjects reported to the 1/212th briefing room between 0500 and 0600. Illuminance in briefing rooms were appropriate for reading and writing, but they were below 2,000 lux. Consequently, a practical fatigue countermeasure is to add light fixtures to each briefing room so that the average illuminance exceeded 2,000 lux. Upon arrival to the daily preflight briefings, aviators and air crew then will be exposed to bright environmental illumination which will increase alertness during the morning hours, decrease fatigue, and facilitate the advance of sleep onset to early evening. This procedure can result in the achievement of steady state entrainment to the EM schedule.

2. Consistent sleep/wake timing.

In addition to changing environmental lighting, it also is critical to maintain consistent sleep/wake times throughout any shiftwork transition. Daily routines provide consistent input to the biological clock resulting in stable synchronization of clock-dependent physiological rhythms.

General recommendations to army aviation

The following countermeasures are offered as a way to prevent sleep loss and to maintain sleep duration throughout frequent shiftwork transitions. These countermeasures are recommended to aviation personnel who are required to work nights or early morning shift schedules. However, this information can not be completely generalized to other shiftwork situations. General guidelines for the design of shift work schedules and crew rest strategies have been published elsewhere (Comperatore, 1993).

1) In the first 3 days of shiftwork transitions involving early morning or nighttime duty hours:

a) Personnel should be encouraged to nap during the late afternoon and early evening to minimize the effects of sleep loss on their performance during actual flights.

b) Shift durations may be adjusted to less than 8 hours (e.g., 5 or 6 hours) and may be used during the first 2 to 3 days of the transition to nighttime duty hours.

2) Shiftwork rotations extending beyond 2-3 weeks should be minimized if possible. Some individuals will experience more difficulty in adapting to nighttime duty hours or early morning reporting times for long periods of time, others will prefer long duration night shifts. Since age and state of health will affect individual choices, scheduling 2 week-night shift periods may suit both preferences. In addition, frequent shiftwork rotations within 1-2 weeks should be avoided. Rapid rotations (within 24 to 48 hours) from day to night or day to early morning shifts are more likely to result in performance degradation and shiftwork maladaptation.

3) When possible, crew should sleep in darkened bedrooms to provide the body clock with a well defined daily light-dark cycle. Bedrooms at home should be maintained with low light and low levels of environmental noise. Commercially available sound masking devices can be used to promote sleep throughout the night and in the morning hours when normal family activities (noise) may disrupt a night shifter's deep sleep. Blinds capable of reducing daylight illuminance are necessary to maintain a sufficiently darkened environment after sunrise. Sleeping in a darkened environment is as important in the readjustment of the sleep/wake cycle as is bright light exposure after awakening (Czeisler et al., 1990).

4) Promote outdoor activities during off-duty hours. Outdoor activities, such as scheduled physical exercise periods, are recommended upon awakening to ensure a consistent schedule of daylight exposure. Avoid shiftwork schedules that will cause awakening to occur after sunset. Daylight exposure will facilitate the adaptation to the new work/rest schedule by resetting the body's biological timing system, particularly after transitions to nighttime duty hours or after returning to daytime duty hours. Transitions to early morning duty hours will require exposure to bright lights (above 2000 lux) upon arrival at the facility.

5) Consistent meal times will facilitate adjustment to the new work/rest schedule. Snacks scheduled prior to bedtime should always be low in fat content to avoid taxing the digestive system. In general, promote consistent meal times during any shiftwork transition. Gastrointestinal complaints are common in night shifters and shift workers in general (Aanonsen, 1964; Angersbach et al., 1980). In particular, during transitions to early morning duty hours, encourage personnel to eat breakfast to avoid abrupt changes in energy availability at the beginning of the work period.

6) Coffee consumption less than 3 hours prior to bedtime is discouraged while consumption is permitted at the beginning of the shift, be it early morning, day, afternoon, or night. However, personnel should be encouraged to reduce caffeine intake in general. Reducing total daily caffeine intake will help to avoid or minimize addiction, and thus enhance caffeine's alertness-enhancing effects when needed (Lieberman, 1993).

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Appendix A.

Tables

Table 1.

Average bed and rise times.
Day shift to early morning shift

Subject #	<u>Bedtime</u>		<u>Rise time</u>	
	Day	Morning	Day	Morning
1	2250	2051	0710	0322
2	0026	2305	0814	0432
3	2209	2148	0739	0401
4	0044	2122	0831	0424
5	2351	2233	0650	0439
6	2258	2122	0728	0404
7	2227	2253	0625	0450
n = 7				
Mean	2320	2159	0728	0416
SD	59.9	51.2	44.6	29.6

Table 2.

Average bedrest duration.
Day shift to early morning shift

Subject #	Day	Morning
1	8.11	6.50
2	7.43	5.43
3	9.78	6.22
4	7.78	7.03
5	6.98	6.12
6	8.52	6.50
7	7.95	5.95
n = 7		
Mean	8.04	6.25
SD	0.80	0.50

Table 3.

Average bed and rise times.
Day shift to night shift

Subject #	<u>Bedtime</u>		<u>Rise time</u>	
	Day	Night	Day	Night
8	0008	0132	0832	0857
9	0150	0305	0832	0924
10	2222	0155	0637	0947
11	0103	0146	0816	0859
n = 4				
Mean	2421	0212	0759	0917
SD	89.3	41.3	55.2	23.6

Table 4.

Average bedrest duration.
Day shift to night shift

Subject #	Day	Night
8	8.83	7.42
9	6.72	6.25
10	8.20	7.88
11	8.45	7.23
n = 4		
Mean	8.05	7.20
SD	0.92	0.69

Table 5.

Average bed and rise times.
Day shift to afternoon shift

Subject #	<u>Bedtime</u>		<u>Rise time</u>	
	Day	Afternoon	Day	Afternoon
12	2320	0023	0735	0916
13	2353	0042	0602	0857
14	2104	2222	0522	0955
n = 3				
Mean	2246	2349	0620	0923
SD	89.4	75.8	68.1	29.7

Table 6.

Average bedrest duration.
Day shift to afternoon shift

Subject #	Day	Afternoon
12	6.17	8.15
13	8.17	8.88
14	8.17	10.65
n = 3		
Mean	7.50	9.23
SD	1.15	1.29

Table 7.

Average bed and rise times.
Day shift

Subject #	Bedtime	Rise time
15	2219	0524
16	2352	0652
n = 2		
Mean	2310	0614
SD	65.8	62.4

Table 8.

Average bedrest duration.
Day shift

Subject #	Day
15	8.08
16	7.39
n = 2	
Mean	7.74
SD	0.49

Table 9.

Average bed and rise times.
Night shift

Subject #	Bedtime	Rise time
17	0229	1055

Table 10.

Average bedrest duration.
Night shift

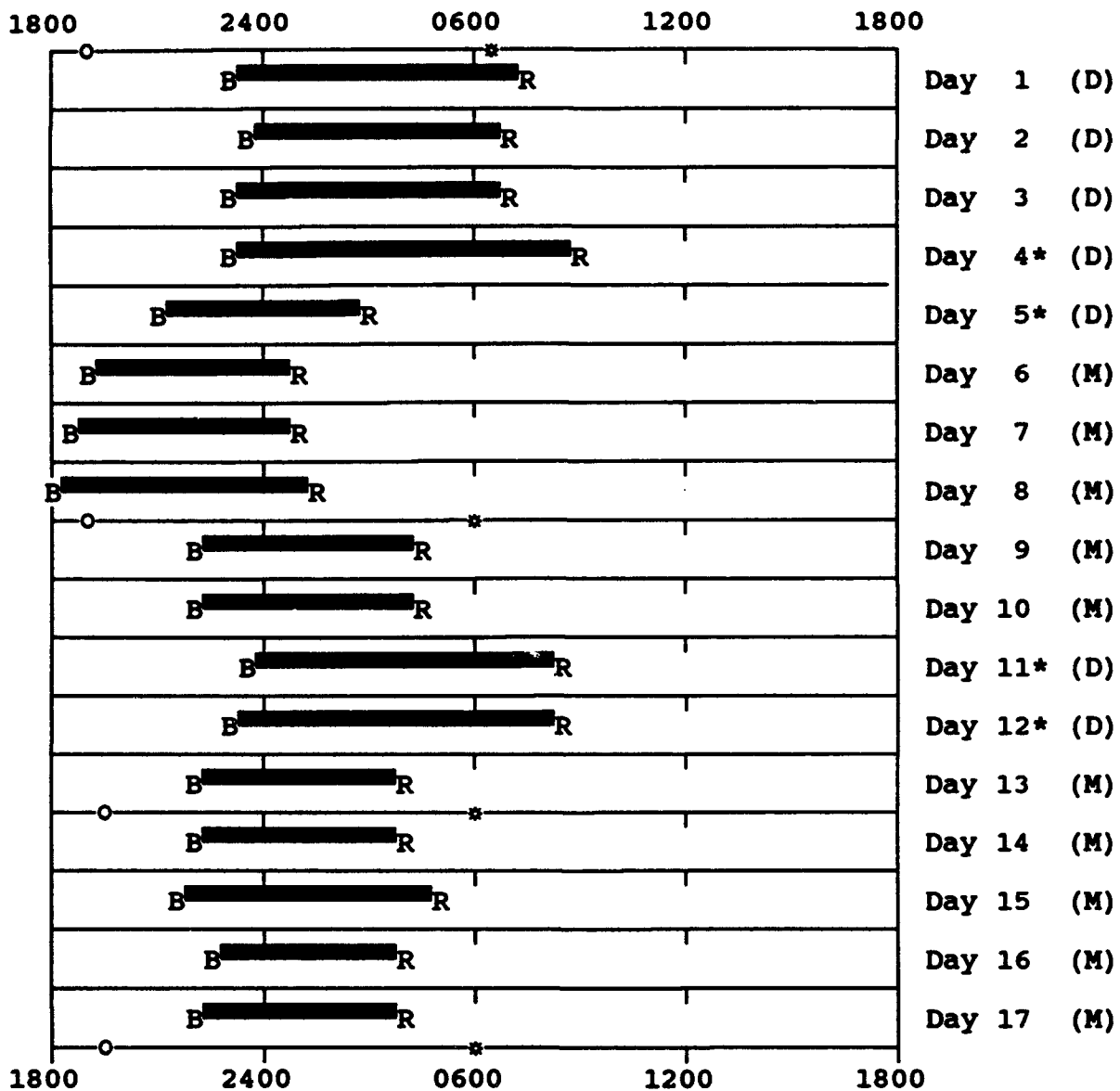
Subject #	Day
17	8.43

Appendix B.

Figures

Bed and rise times

Subject 1 (D/M)



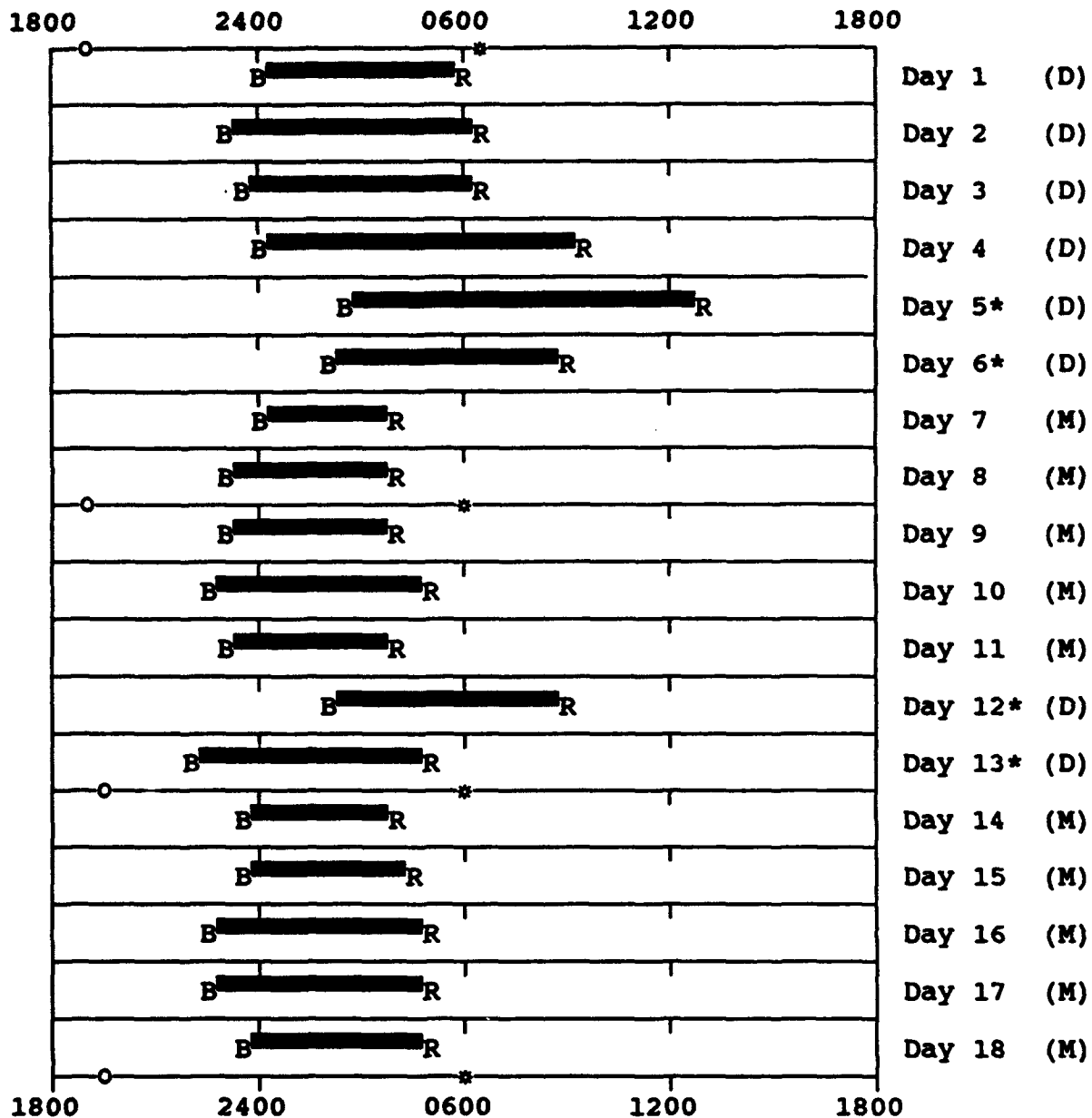
Legend:

- * = weekend
- B = bedtime
- M = morning shift
- O = sunset
- = total rest
- R = rise time
- D = day shift
- * = sunrise

Figure 1. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study. Bed and rise times

Bed and rise times

Subject 2 (D/M)



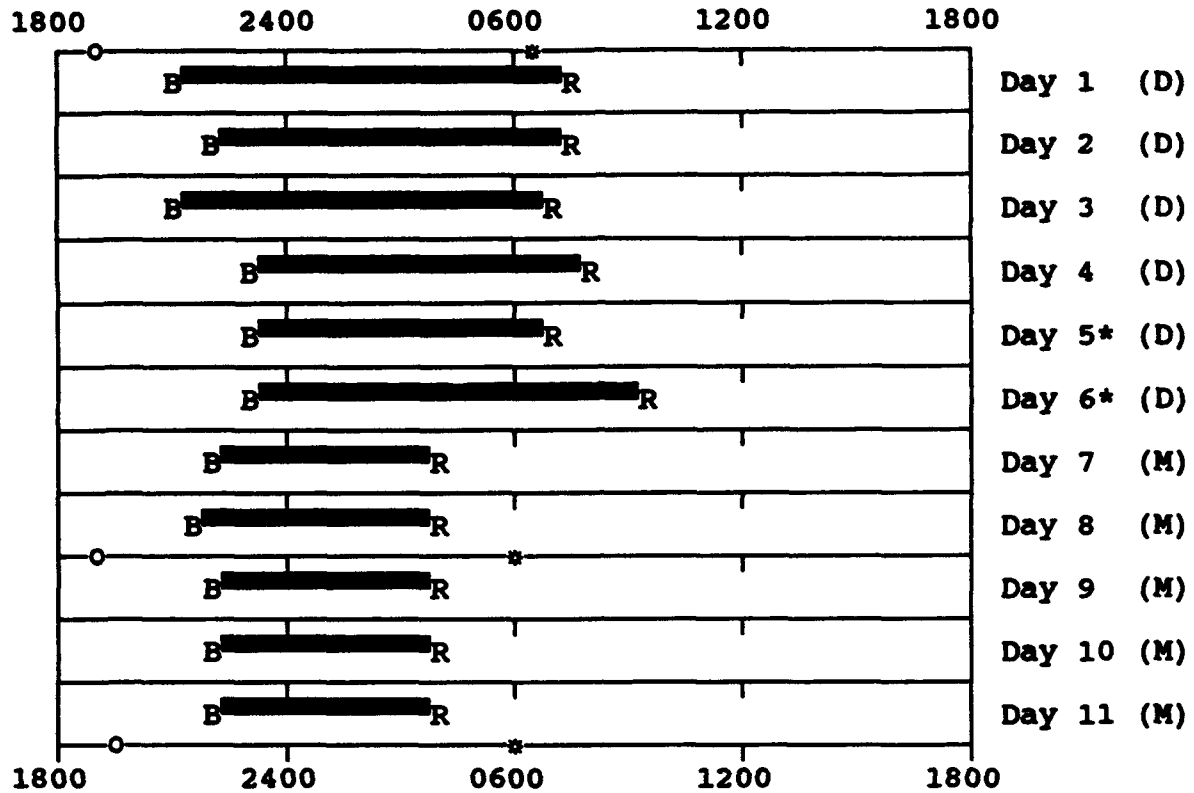
Legend:

- * = weekend
- B = bedtime
- D = day shift
- O = sunset
- = total rest
- R = rise time
- M = morning shift
- * = sunrise

Figure 2. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 3 (D/M)



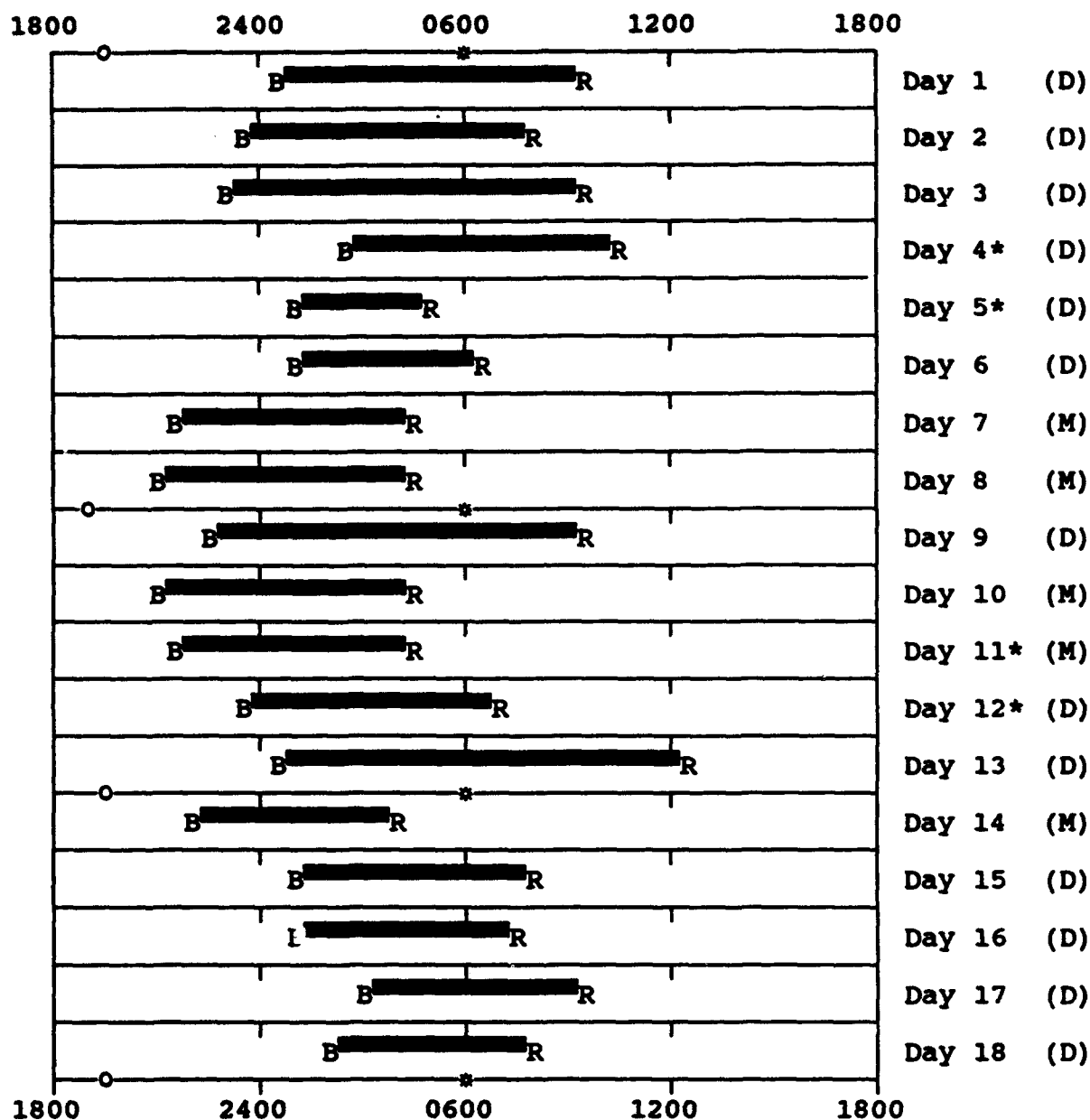
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- M = morning shift
- * = sunrise

Figure 3. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 4 (D/M)



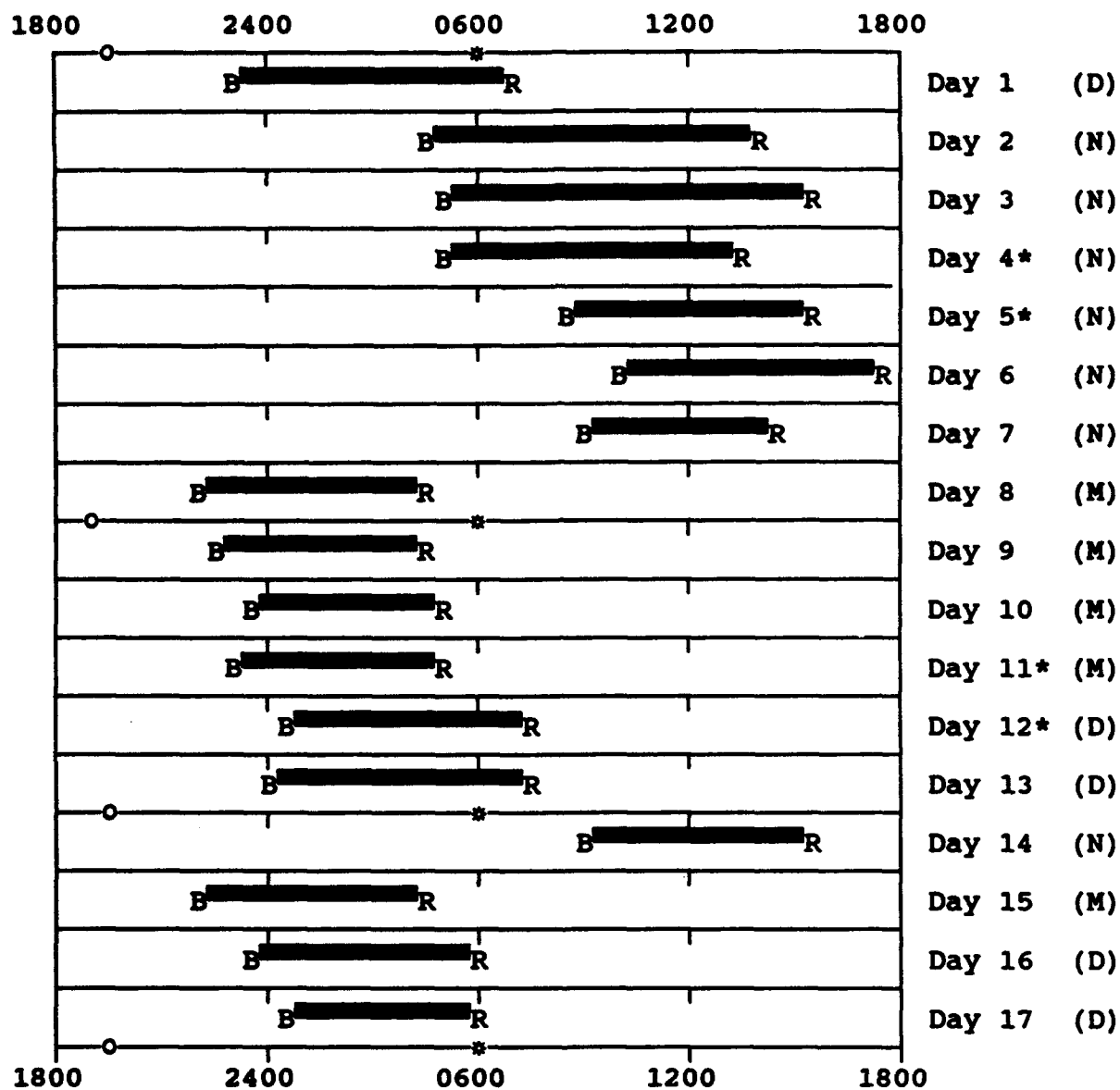
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- M = morning shift
- * = sunrise

Figure 4. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 5 (D/M/N)



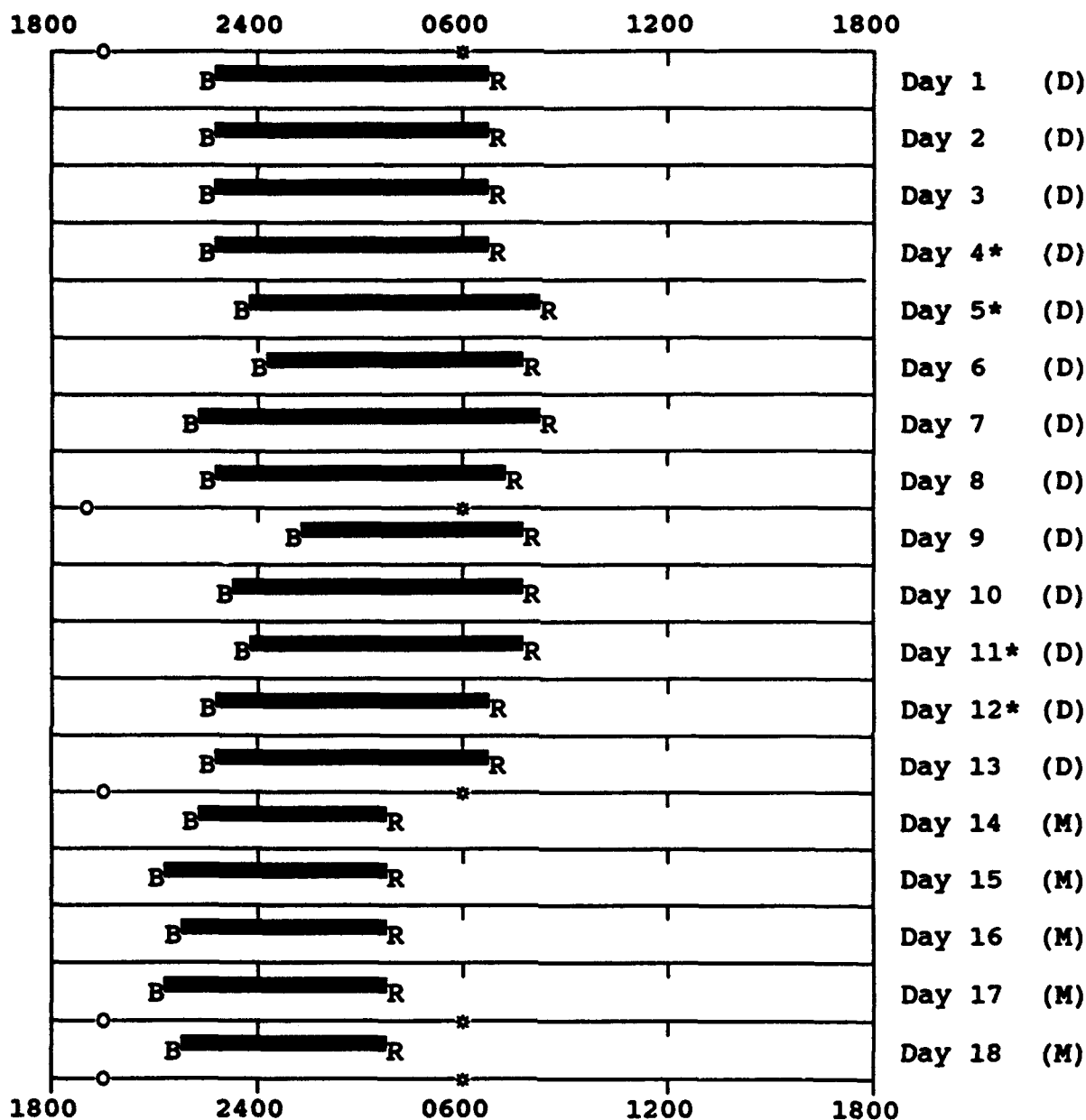
Legend:

- * = weekend
- B = bedtime
- D = day shift
- N = night shift
- * = sunrise
- = total rest
- R = rise time
- M = morning shift
- o = sunset

Figure 5. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 6 (D/M)



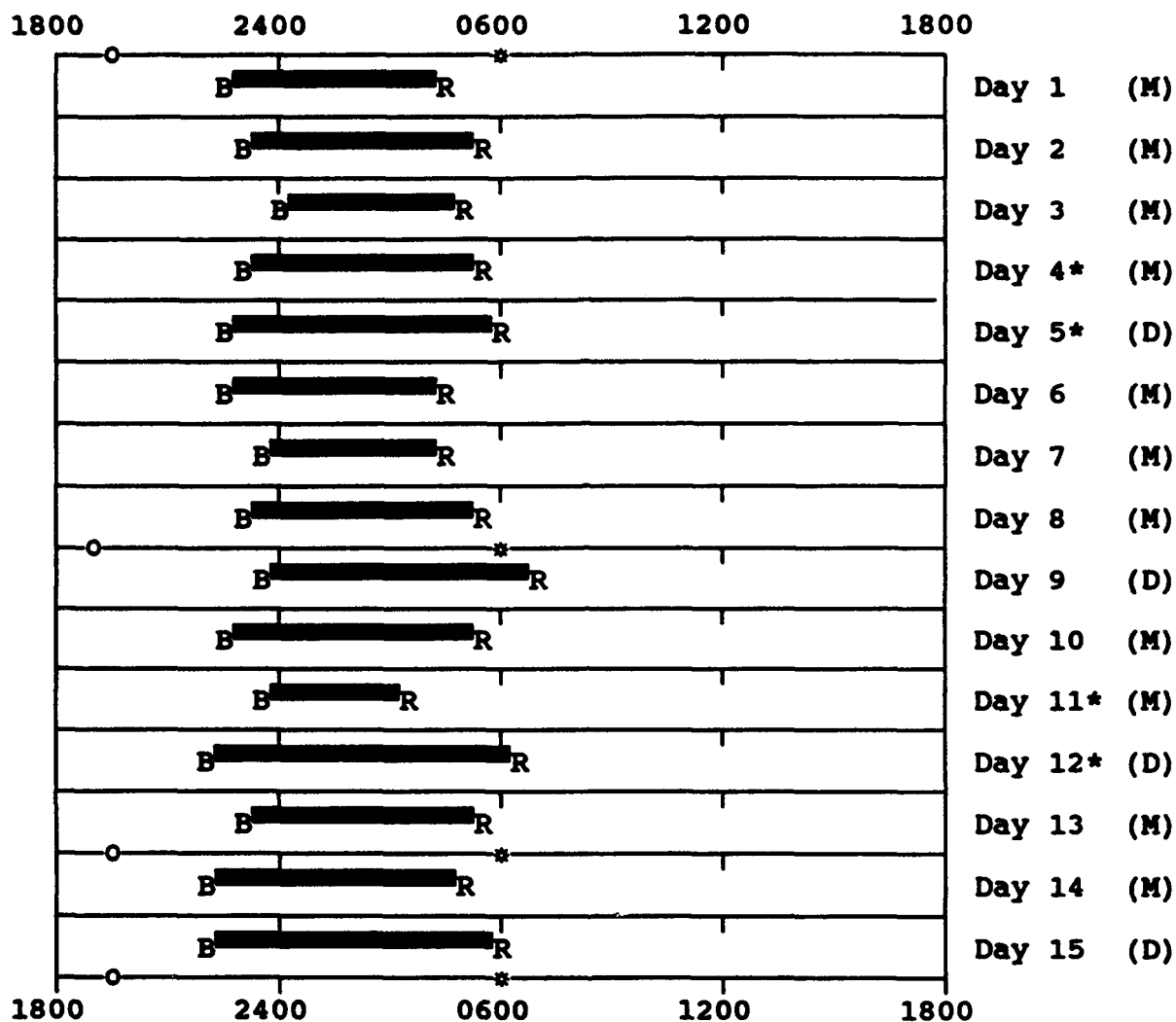
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- M = morning shift
- * = sunrise

Figure 6. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 7 (D/M)



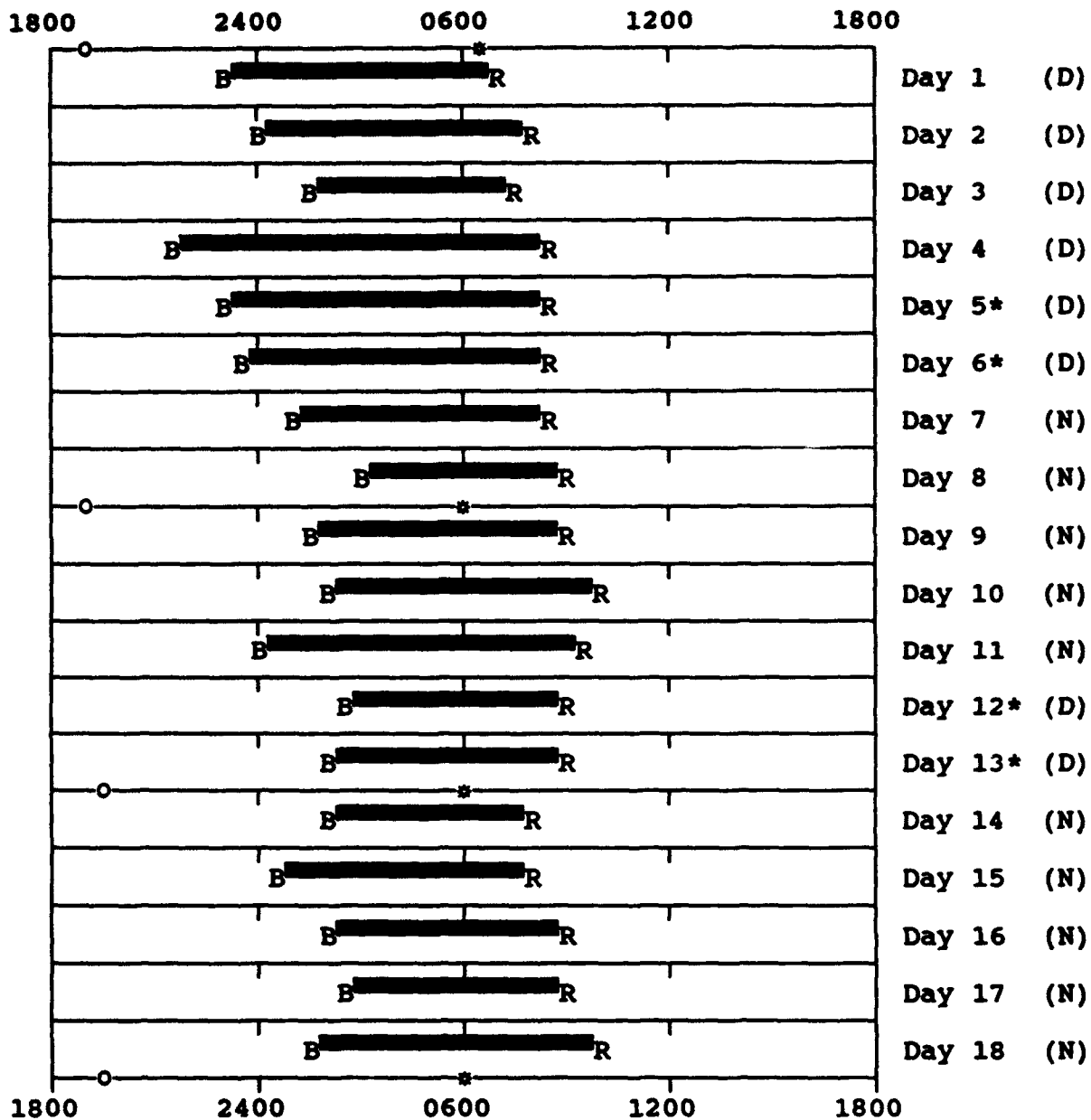
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- M = morning shift
- * = sunrise

Figure 7. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 8 (D/N)



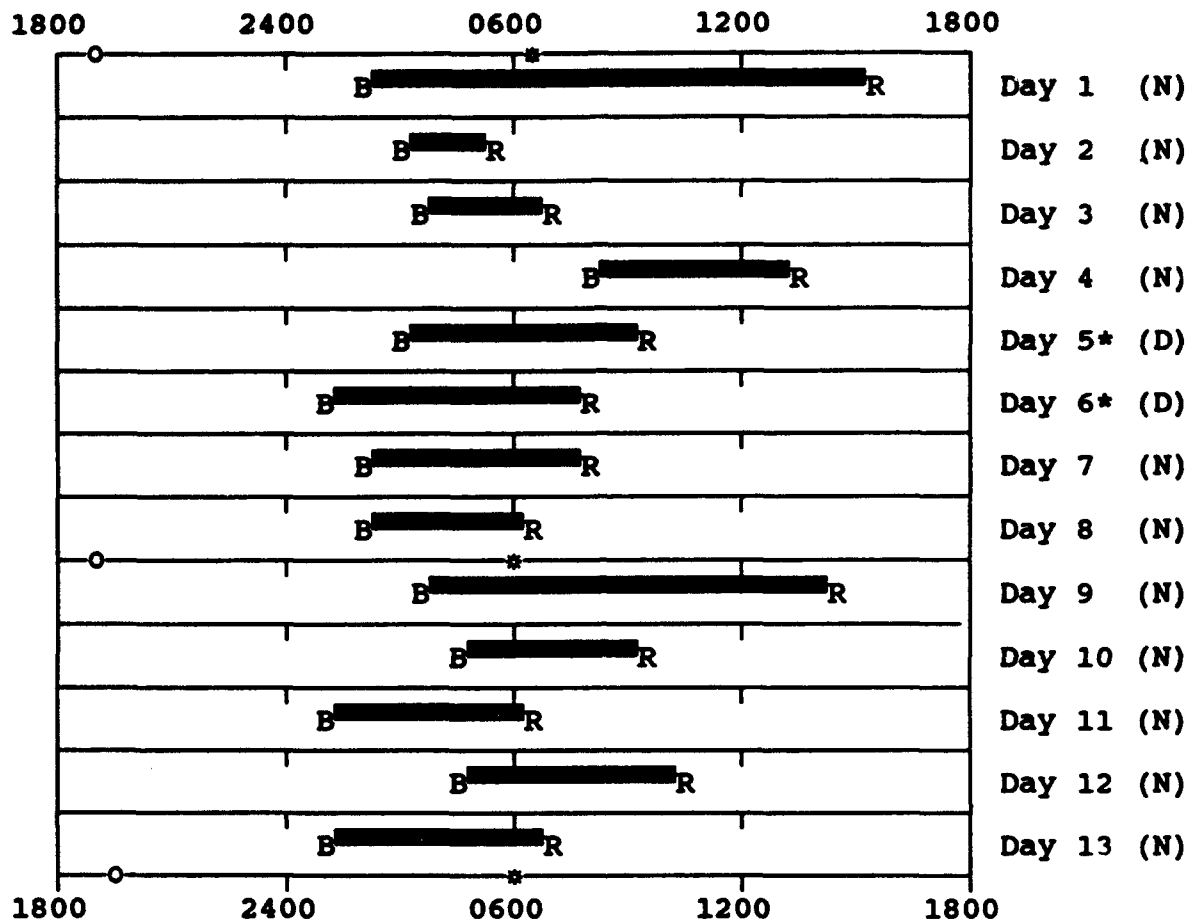
Legend:

- * = weekend
- B = bedtime
- D = day shift
- O = sunset
- = total rest
- R = rise time
- N = night shift
- * = sunrise

Figure 8. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 9 (D/N)



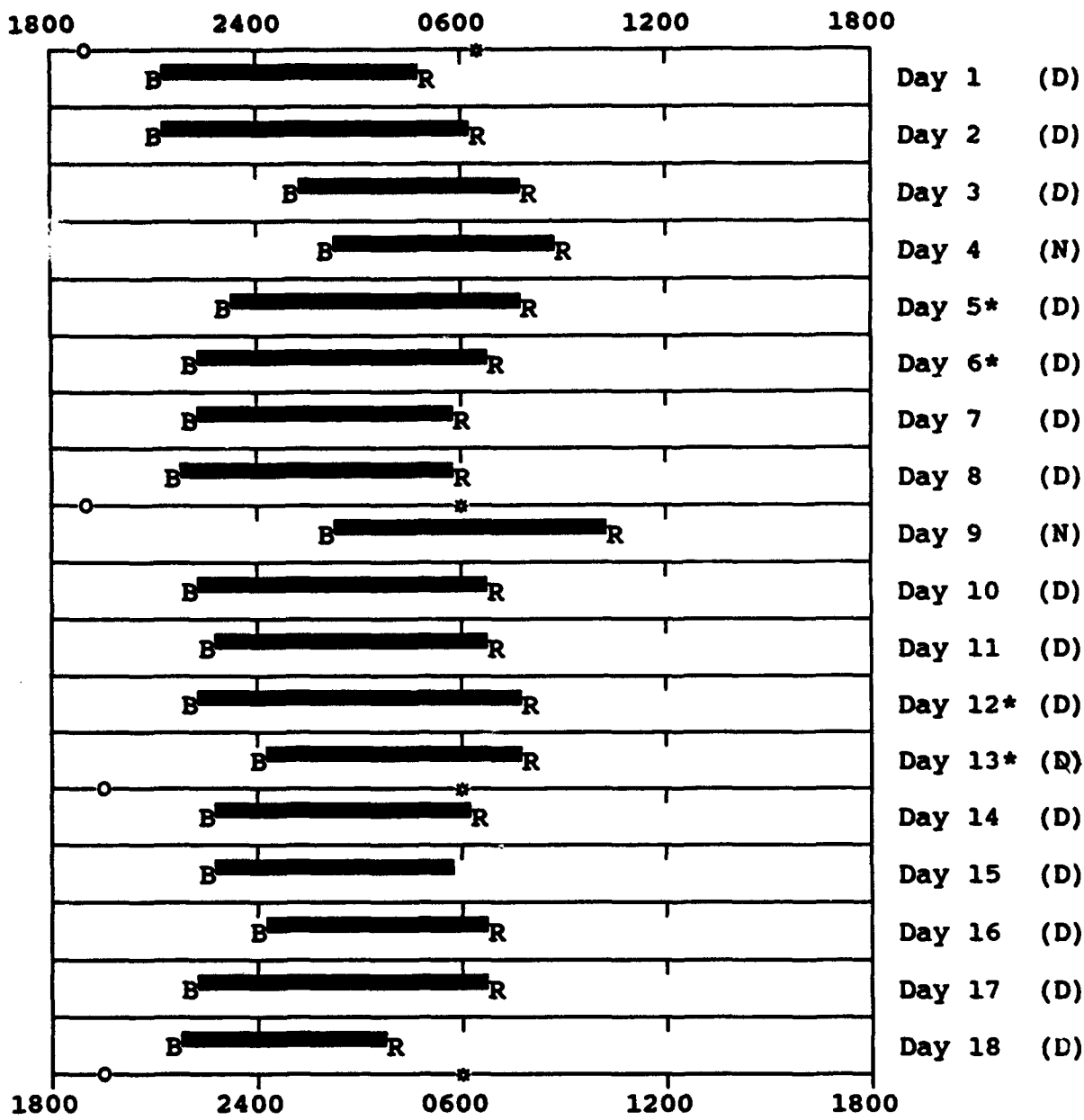
Legend:

* = weekend	■ = total rest
B = bedtime	R = rise time
D = day shift	N = night shift
O = sunset	* = sunrise

Figure 9. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 10 (D/N)



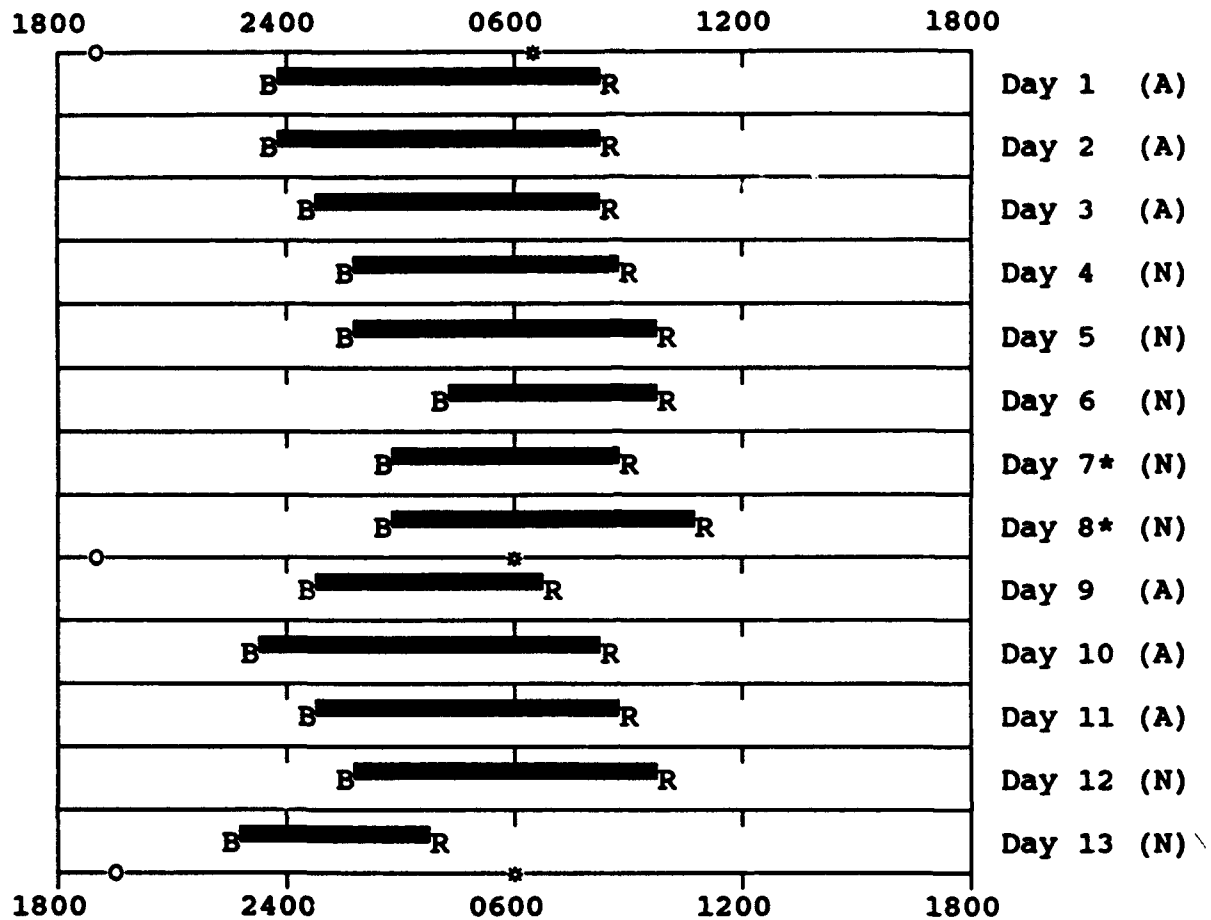
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- N = night shift
- * = sunrise

Figure 10. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 11 (A/N)



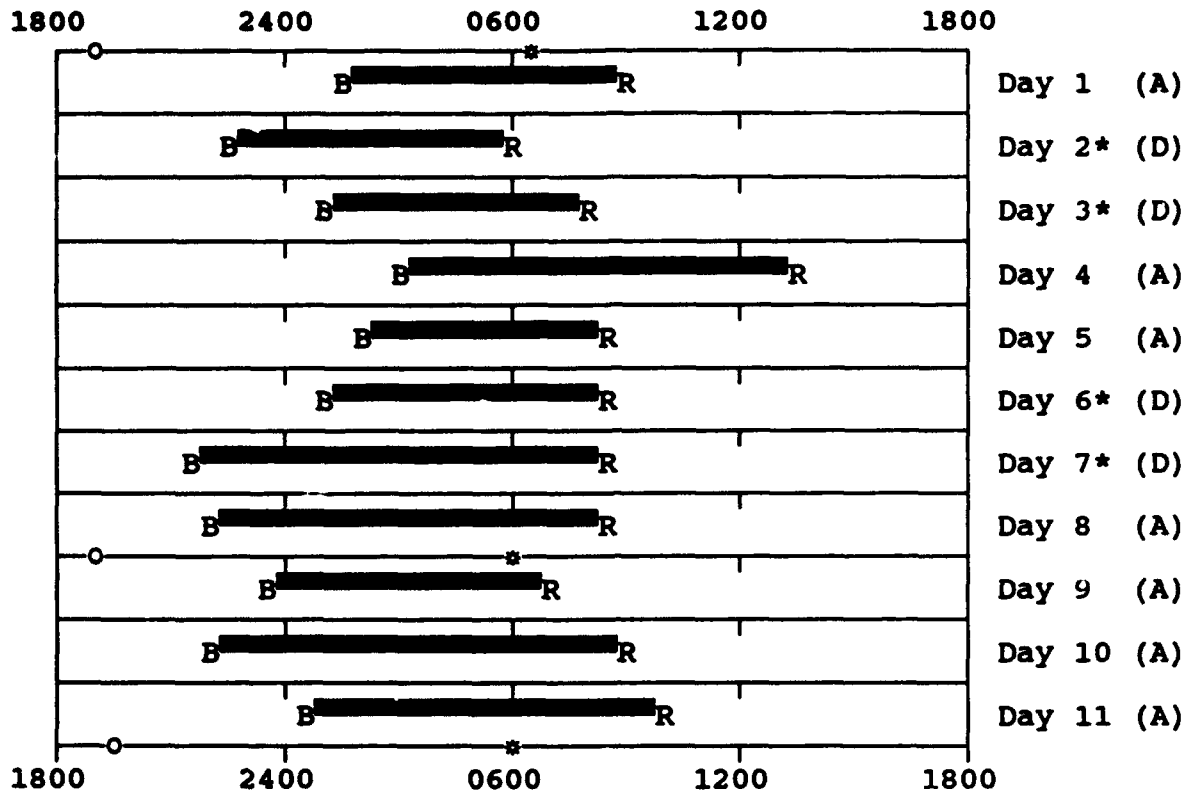
Legend:

* = weekend	■ = total rest
B = bedtime	R = rise time
N = night shift	A = afternoon shift
O = sunset	* = sunrise

Figure 11. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 12 (D/A)



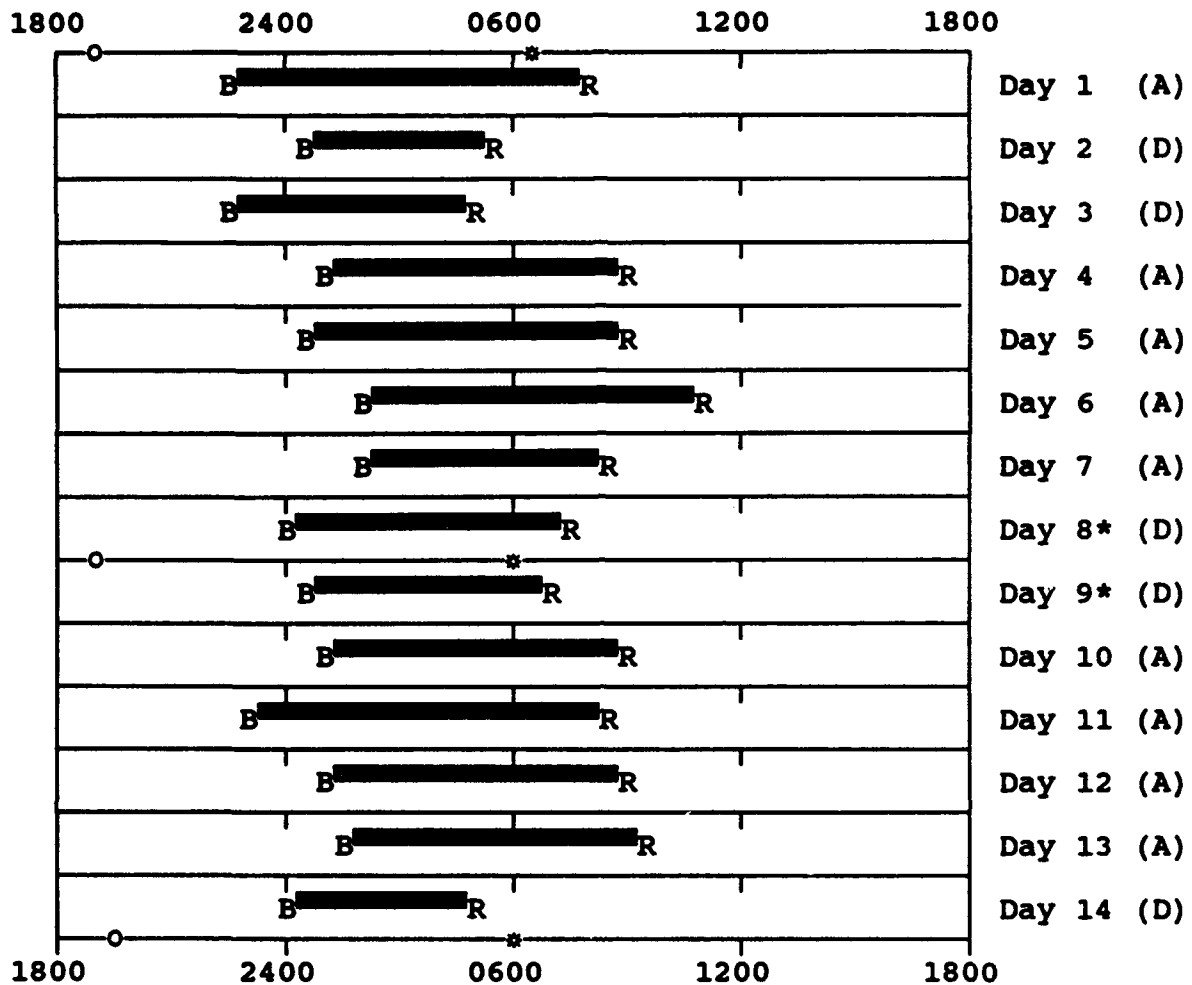
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- A = afternoon shift
- * = sunrise

Figure 12. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 13 (D/A)



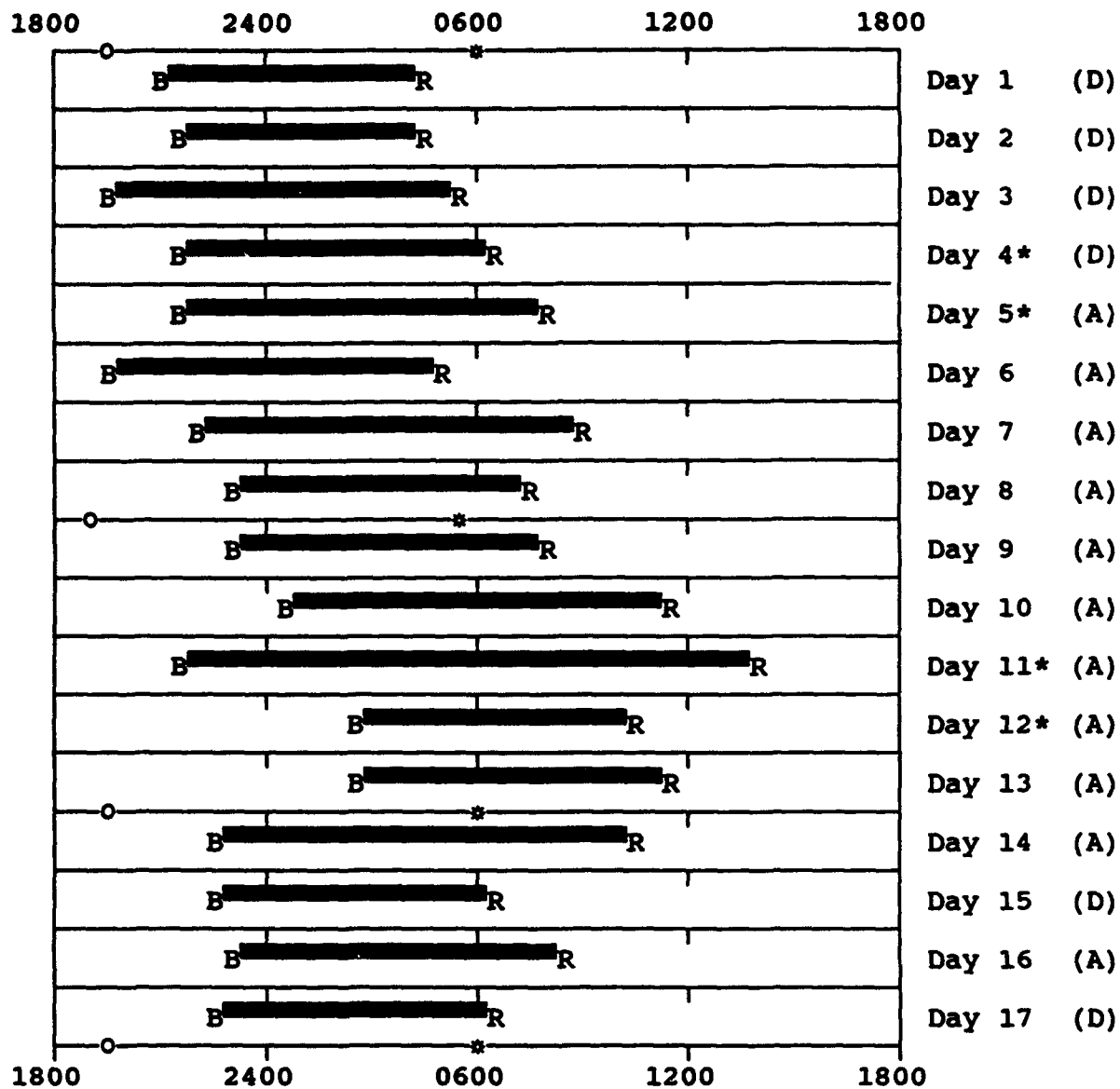
Legend:

- * = weekend
- B = bedtime
- D = day shift
- o = sunset
- = total rest
- R = rise time
- A = afternoon shift
- * = sunrise

Figure 13. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 14 (D/A)



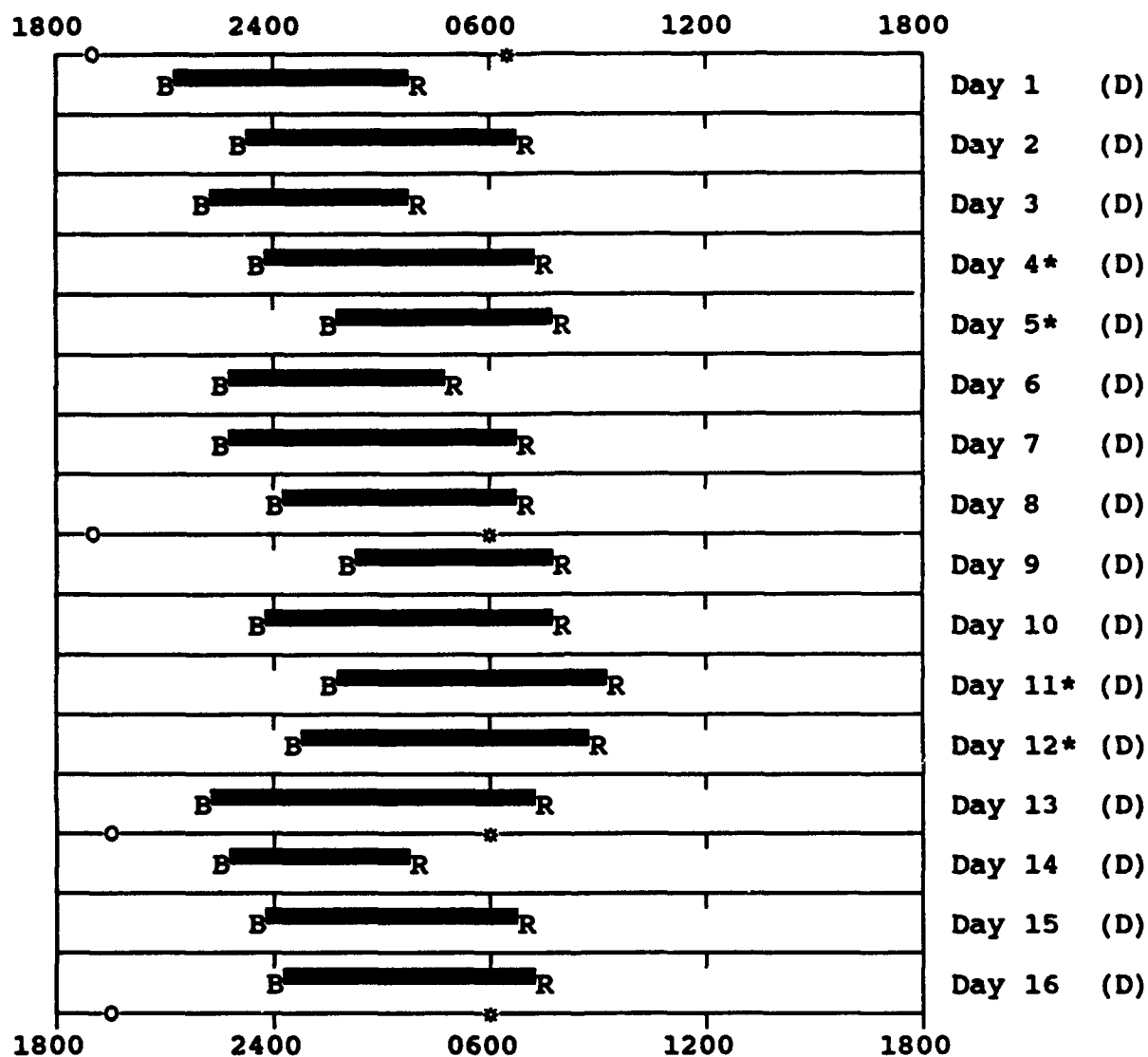
Legend:

- * = weekend
- B = bedtime
- D = day shift
- O = sunset
- = total rest
- R = rise time
- A = afternoon shift
- * = sunrise

Figure 14. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 15 (D)



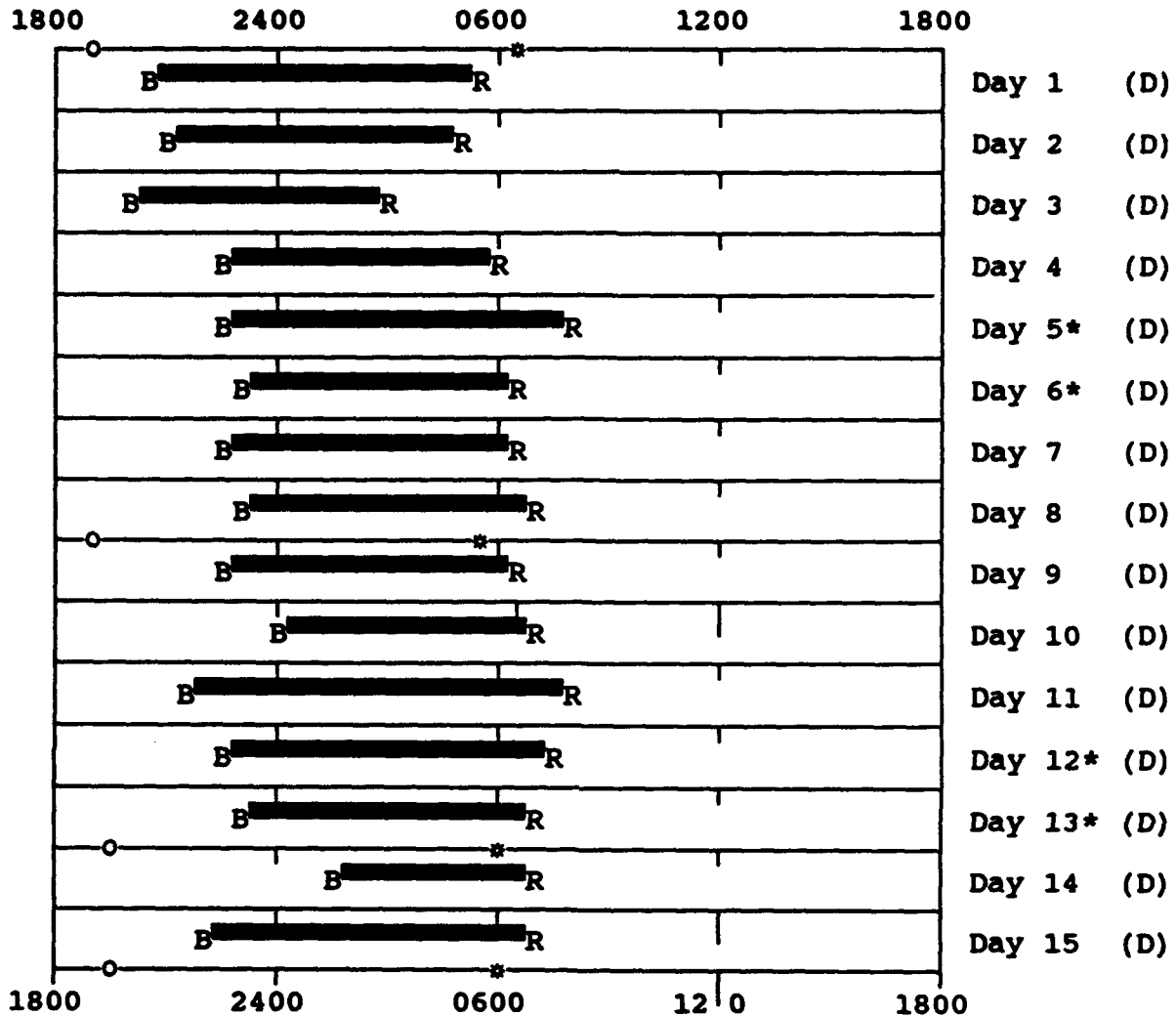
Legend:

- * = weekend
- B = bedtime
- D = day shift
- * = sunrise
- = total rest
- R = rise time
- o = sunset

Figure 15. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 16 (D)



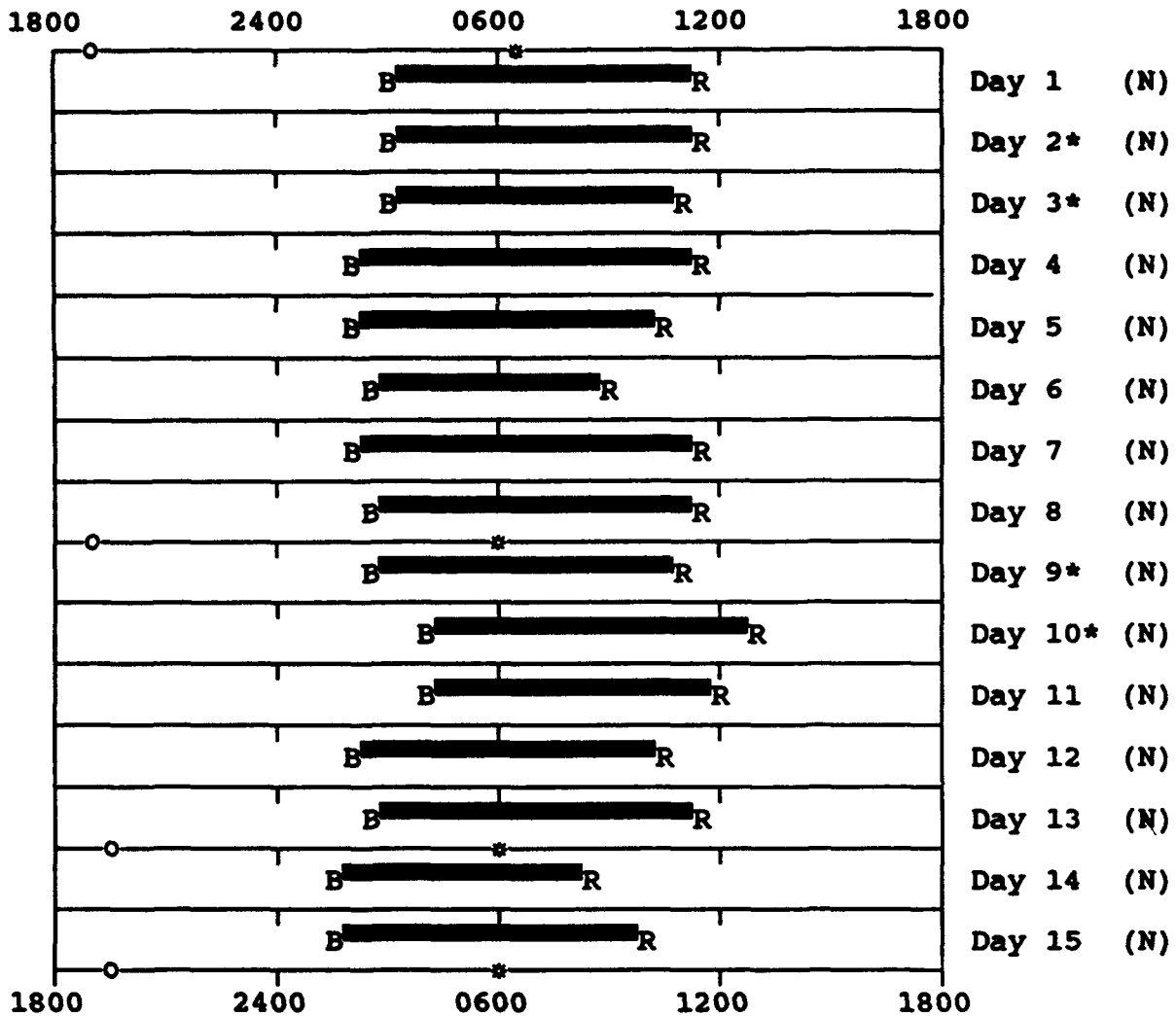
Legend:

- * = weekend
- B = bedtime
- D = day shift
- * = sunrise
- = total rest
- R = rise time
- o = sunset

Figure 16. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

Bed and rise times

Subject 17 (N)



Legend:

- * = weekend
- B = bedtime
- N = night shift
- * = sunrise
- = total rest
- R = rise time
- o = sunset

Figure 17. Bedtime and rise time, bedrest duration, sunrise and sunset, and work schedule throughout the study.

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